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IN THE MATTER OF

U.S. Patent Application No. 09/960,305

By Samsung Electronics Co., Ltd.

I, Young-ju Lee, an employee of Y.P.LEE,MOCK & PARTNERS of The Cheonghwa Bldg., 1571-18 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare that I am familiar with the Korean and English languages and that I am the translator of the priority document (Korean Patent Application No. 01-3747) and certify that the following is to the best of my knowledge and belief a true and correct translation.

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Youngju Lee

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PATENT
P56519

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

SU-JONG JEONG

Serial No.:	09/960,305	Examiner:	LEE, SUSAN
Filed:	24 September 2001	Art Unit:	2852

For: METHOD AND APPARATUS FOR AN ELECTROPHOTOGRAPHIC PRINTER WHERE VOLTAGE MAGNITUDE APPLIED TO CHARGE ROLLER AND INTENSITY OF ILLUMINATION UNIT VARY DEPENDING ON TYPE OF PRINT JOB SUBMITTED (as amended)

TRANSMITTAL OF ENGLISH TRANSLATION

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Transmitted herewith is the English translation of Korean Priority Document No. 2001-53747, for the above-referenced application.

Respectfully submitted,

Robert E. Bushnell,
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Date: 7/7/2003
I.D.: REB/rfc

SPECIFICATION

[Title of the Invention]

Electrophotographic Printing Method

[Brief Description of the Drawings]

FIG. 1 is a block diagram of the structure of a general electrophotographic imaging system;

FIG. 2 is a flowchart of a general electrophotographic printing method;

FIG. 3 shows the correlation between laser scanning unit (LSU) power, organic photoconductor (OPC) potential, and dot size;

FIG. 4 is a flowchart illustrating a preferred embodiment of an electrophotographic printing method according to the present invention; and

FIG. 5 shows the relation between LSU power and OPC potential for a certain dot size with respect to charge voltage variations.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an electrophotographic printing method, and more particularly, to an electrophotographic printing method in which a charge voltage is appropriately varied depending on the print resolution or print mode.

As shown in FIG. 1, a general electrophotographic imaging system, such as a copy machine, printer or facsimile, includes a controller 10 for controlling formation of an image, a laser scanning unit (LSU) 11, a high-voltage power supply (HVPS) 12, a charge roller 13, a photoreceptor drum serving as an organic photoconductor (OPC) 14, a developer roller 15, a transfer roller 16, and a blade 17.

Under the control of the controller 10, the HVPS 12 supplies a charge voltage of −1.4 kV to the charge roller 13, a development voltage of −300 V to the developer roller 15, and a transfer voltage of +2.0 kV to the transfer roller 16.

As the development voltage of −300 V is applied to the developer roller 15 by the HVPS 12, toner particles which almost have a negative charge are attracted to the surface of the developer roller 15 by frictional force acting between a toner supply roller (not shown) and the developer roller 15. However, due to a large amount of stress between the toner supply roller and the developer roller 15 and irregular toner particle size, toner particles having a positive charge may be applied to the surface of the developer roller 15. The charge roller 13 is formed of a conductive roller having an appropriate resistance. As a voltage of −1.4 kV is applied to the charge roller 13, the surface of the OPC 14 is charged to a negative potential of −800 V. Under the control of the controller 10, the LSU 11 scans the surface of the OPC 14 with a beam to form an electrostatic latent image on the OPC 14. Here, an image area in which the electrostatic latent image is formed has a potential of −50 V, and a non-image area has a potential of −800 V.

Meanwhile, as the electrostatic latent image area of the OPC 14 passes the developer roller 15, toner particles adhering to the surface of the developer roller 15 migrate to the electrostatic latent image area of the OPC 14 by potential difference, so that a visible image is formed on the surface of the OPC 14. The visible image formed on the surface of the OPC 14 is transferred to and printed on a paper passing through a gap, which is also called a "nip", between the OPC 14 and the transfer roller 16. The blade 17 is used to mechanically remove the toner particles remaining on the surface of the OPC 14.

FIG. 2 is a flowchart illustrating a general electrophotographic printing method. When a print command is input from a user, an image which is intended to be printed is input to an electrophotographic imaging apparatus through a personal computer (PC). The controller 10 starts to operate (ON-state) to form a matrix of dots in accordance with the input image (Step 20). A charge voltage of −1.4 kV is applied to the charge

roller 13 under the control of the controller 10 to charge the OPC 14 to a potential of -800 V (Step 21).

As the LSU 11 scans the matrix of dots formed on the surface of the OPC 14 with a laser beam in response to a control signal from the controller 10, the potential of the exposed area is changed to have a potential of -50 V and the non-exposed remains at a potential of -800 V (Step 22).

When toner particles are applied to the exposed area of the OPC 14 to form a visible image, a sheet of paper is fed through the nip formed between the transfer roller 16 and the OPC 14. As a high voltage of 500-3,000 V is applied to the transfer roller 16, the toner image formed on the OPC 14 is transferred to the paper. The toner particles remaining on the OPC 14 which are not transferred to the paper are removed by the blade 17 and transferred into a recycled toner container (not shown). As the paper passes a fusing unit (not shown), a permanent image is printed on the paper by hot pressing (Step 23). If it is determined to continue printing (Step 24), the process returns to Step 20 and the above-described steps are repeated.

FIG. 3 shows the correlation between LSU power, OPC potential, and dot size. The smaller the dot size, the greater the plot slopes. A greater slope means that the potential variation of the OPC (Y-axis) is increased by variations of the LSU power (X-axis). Here, the potential variation of the OPC is proportional to gray pattern level variation. As can be inferred from FIG. 3, assuming that the same printing conditions are applied, the gray level variation is greater for the 1 by 1 dot size than for the 4 by 4 dot size. The same result can be obtained from comparison of the printing results at resolutions of 600 dots per inch (dpi.) and 1200 dpi. In other words, because the dot size is smaller at 1200 dpi. than at 600 dpi., the gray level variation is greater at 1200 dpi. Thus, there is a problem that a desired high quality print output cannot be obtained.

[Technical Goal of the Invention]

To solve the above-described problems, it is a first object of the present invention to provide an electrophotographic printing method in which a charge voltage is appropriately varied depending on the print resolution.

It is a second object of the present invention to provide an electrophotographic printing method in which a charge voltage is appropriately varied depending on print mode.

[Structure and Operation of the Invention]

To achieve the first object of the present invention, there is provided an electrophotographic image printing method for an electrophotographic imaging apparatus including: a charge roller; a developer roller; a laser scanning unit (LSU); a transfer roller; an organic photoconductor (OPC); a power supply unit for supplying power to the charge roller, the developer roller, the LSU, the transfer roller, and the OPC; and a controller for controlling the charge roller, the developer roller, the LSU, the transfer roller, and the OPC, the method comprising: (a) selecting a resolution for electrophotographic printing; (b) charging the OPC by applying to the charge roller an appropriate charge voltage depending on the selected resolution; (c) forming an electrostatic latent image on the charged OPC by the LSU and applying toner particles adhering to the developer roller to the electrostatic latent image to form a visible image; and (d) transferring the visible image formed on the OPC to a sheet of print paper.

It is preferable that, when the resolution selected in step (a) has a lower level, the charge voltage of step (b) is set to be higher than when the resolution selected in step (b) has a higher level.

To achieve the second object of the present invention, there is provided an electrophotographic printing method for an electrophotographic imaging apparatus including: a charge roller; a developer roller; a laser scanning unit (LSU); a transfer roller; an organic photoconductor (OPC); a power supply unit for supplying power to the charge roller, the developer roller, the LSU, the transfer roller, and the OPC; and a controller for controlling the charge roller, the developer roller, the LSU, the transfer roller

roller, and the OPC, the method comprising: (a) selecting a print mode for electrophotographic printing; (b) charging the OPC by applying to the charge roller an appropriate charge voltage depending on the selected print mode; (c) forming an electrostatic latent image on the charged OPC by the LSU and applying toner particles adhering to the developer roller to the electrostatic latent image to form a visible image; and (d) transferring the visible image formed on the OPC to a sheet of print paper.

It is preferable that the print mode of step (a) includes a text mode and a graphics mode, and the charge voltage of step (b) is set to be higher in the text mode than in the graphics mode.

The present invention will now be described in detail.

FIG. 4 is a flowchart illustrating a preferred embodiment of an electrophotographic printing method according to the present invention. The electrophotographic printing method involves turning on a controller (Step 40); determining whether the resolution is 200 dots per inch (dpi.) (Step 41); turning on a charge roller with application of a voltage of -1.4 kV or -1.35 kV (Step 42 or 43); turning on a laser scanning unit (LSU) (Step 44); turning on a transfer roller and cleaning a photoreceptor drum serving as an organic photoconductor (OPC) (Step 45); and determining whether to continue printing (Step 46).

FIG. 5 shows the relation between LSU power and OPC potential for a certain dot size with respect to charge voltage variations. FIGS. 1, 4, and 5 are referred to in the following description.

In particular, when a user inputs a print command through a personal computer (PC) to print an image, the controller 10 (see FIG. 1) is turned on to graphic process an electric image to be printed (Step 40). The controller 10 performs an appropriate graphic process depending on the resolution or print mode selected by the user. The user sets the resolution (600 dots per inch (dpi.), 1200 dpi., or the like) or the print mode (text mode or graphics mode) before the input of the print command.

In Step 41, it is determined whether the resolution selected by the user is 1200 dpi. (Step 41). If the selected resolution is not 1200 dpi., the high-voltage power

supply (HVPS) 12 applies a charge voltage of −1.4 kV to the charge roller 13 under the control of the controller 10 (Step 42). If the selected resolution is 1200 dpi., the HVPS 12 applies a charge voltage of −1.35 kV to the charge roller 13 under the control of the controller 10 (Step 43). Here, if the resolution is not equal to 1200 dpi., the resolution is considered as 600 dpi. at which the charge voltage −1.4 kV is applied.

The lower the resolution, the greater the gray pattern level variation and the poorer the output image quality. Thus, to enhance the image quality by reducing the gray pattern level variation at a low-resolution, the charge voltage of the charge roller 13 is increased. Meanwhile, for high-resolution image printing, the charge voltage of the charge roller 13 is set to be relatively low to reduce the gray pattern level variation. In the present invention, it is assumed that the charge voltage of the charge roller 13 is −1.4 kV at a low resolution of 600 dpi. and −1.35 kV at a high resolution of 1200 dpi.

In addition, the charge voltage of the charge roller 13 is varied depending on the print mode. The resolution in a text mode is lower than in a graphics mode. Thus, in the low-resolution text mode, the charge voltage of the charge roller 13 is set to −1.4 kV. In the high-resolution graphics mode, the charge voltage of the charge roller 13 is set to −1.35 kV.

Thus, the OPC 14 is appropriately charged with a charge voltage which is varied by the controller 10 depending on the resolution or print mode. When the OPC 14 is charged by the charge roller 13, the controller 10 turns on the LSU 11 (Step 44). When the LSU 11 scans a matrix of dots formed on the surface of the OPC 14 with a laser beam in response to a control signal from the controller 10, the potential of the exposed area changes to −50V and the potential of the non-exposed area remains at −800 V.

After the scanning by the LSU 11, the controller 10 turns on the developer roller 15, the transfer roller 16, and the blade 17 (Step 45). When toner particles adhering to the developer roller 15 are applied to the exposed area of the OPC 14 to form a visible image, a sheet of print paper is fed through a nip formed between the transfer roller 16 and the OPC 14. As a high-voltage of 500-3,000 volts is applied to the transfer roller

16, the visible toner image is transferred to the print paper. Toner particles remaining on the OPC 14, not transferred to the print paper, are removed by the blade 17 and are transferred to a waste toner container (not shown). As the print paper passes a fusing unit, a permanent image is formed and output by hot pressing.

In Step 46, it is determined whether to continue the printing, and the process returns to Step 40 to continue the printing. Then, the above-described Steps 40 through 45 are repeated.

In determining an optimal power level of the LSU 11 for the realization of optimal image quality, data on the relation between LSU power (X-axis) and OPC potential (Y-axis), as shown in FIG. 5, is very important. Referring to FIG. 5, when the charge voltage is 1.35 kV, the OPC potential becomes flat near an LSU power of 0.33 mW. Thus, the optimal power level of the LSU 11 at a charge voltage of 1.35 kV is determined to be about 0.33 mV taking into account LSU tolerance. When the charge voltage is changed to 1.25 kV, the OPC potential becomes flat near an LSU power of 0.27 mW. Thus, the optimal power level of the LSU 11 at a charge voltage of 1.25kV is determined to be about 0.27 mW taking into account LSU tolerance. As can be inferred from FIG. 5, as the charge voltage becomes low, the point at which the OPC potential becomes flat shifts downward. Thus, for high-resolution printing at 1200 dpi, the point at which the OPC potential becomes flat can be shifted downward by reducing the charge voltage, so that the gray pattern formation potential is determined as a low level near the point. As a result, the gray pattern level variation can be reduced with excellent image quality.

While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[Effect of the Invention]

As described above, in an electrophotographic imaging system which allows a user to select the print resolution or print mode, the charge voltage can be appropriately adjusted depending on the print resolution or print mode, so that a high quality image can be obtained with reduced image concentration variation.

What is claimed is:

1. An electrophotographic image printing method for an electrophotographic imaging apparatus including: a charge roller; a developer roller; a laser scanning unit (LSU); a transfer roller; an organic photoconductor (OPC); a power supply unit for supplying power to the charge roller, the developer roller, the LSU, the transfer roller, and the OPC; and a controller for controlling the charge roller, the developer roller, the LSU, the transfer roller, and the OPC, the method comprising:

(a) selecting a resolution for electrophotographic printing;

(b) charging the OPC by applying to the charge roller an appropriate charge voltage depending on the selected resolution;

(c) forming an electrostatic latent image on the charged OPC by the LSU and applying toner particles adhering to the developer roller to the electrostatic latent image to form a visible image; and

(d) transferring the visible image formed on the OPC to a sheet of print paper.

2. The method of claim 1, wherein, when the resolution selected in step (a) has a lower level, the charge voltage of step (b) is set to be higher than when the resolution selected in step (b) has a higher level.

3. An electrophotographic printing method for an electrophotographic imaging apparatus including: a charge roller; a developer roller; a laser scanning unit (LSU); a transfer roller; an organic photoconductor (OPC); a power supply unit for supplying power to the charge roller, the developer roller, the LSU, the transfer roller, and the OPC; and a controller for controlling the charge roller, the developer roller, the LSU, the transfer roller, and the OPC, the method comprising:

(a) selecting a print mode for electrophotographic printing;

(b) charging the OPC by applying to the charge roller an appropriate charge voltage depending on the selected print mode;

(c) forming an electrostatic latent Image on the charged OPC by the LSU and applying toner particles adhering to the developer roller to the electrostatic latent image to form a visible image; and

(d) transferring the visible image formed on the OPC to a sheet of print paper.

4. The electrophotographic printing method of claim 1, wherein the print mode of step (a) includes a text mode and a graphics mode, and the charge voltage of step (b) is set to be higher in the text mode than in the graphics mode.

ABSTRACT

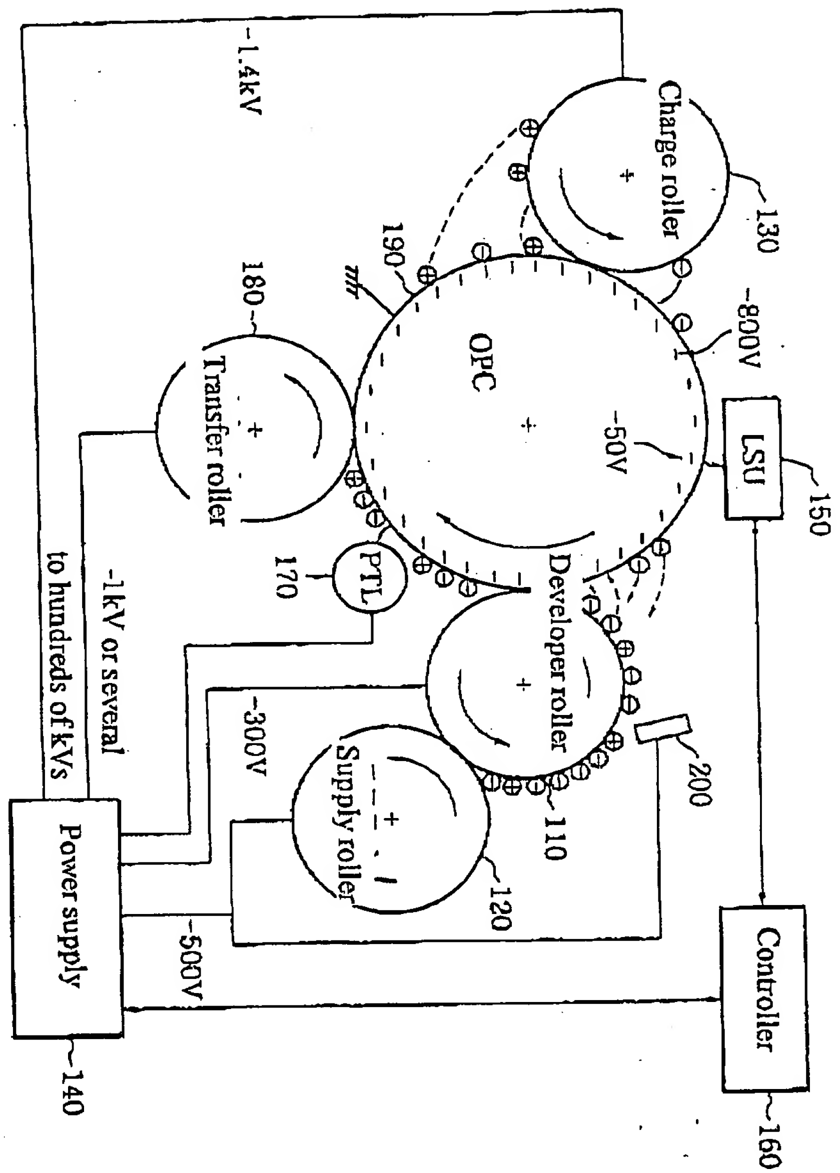
[Abstract of the Disclosure]

An electrophotographic printing method in which a charge voltage is appropriately adjusted depending on the resolution selected for electrophotographic printing or the print mode is provided. The electrophotographic printing method, which is for an electrophotographic imaging apparatus including: a charge roller; a developer roller; a laser scanning unit (LSU); a transfer roller; an organic photoconductor (OPC); a power supply unit for supplying power to the charge roller, the developer roller, the LSU, the transfer roller, and the OPC; and a controller for controlling the charge roller, the developer roller, the LSU, the transfer roller, and the OPC, includes: (a) selecting a resolution for electrophotographic printing; b) charging the OPC by applying to the charge roller an appropriate charge voltage depending on the selected resolution; (c) forming an electrostatic latent image on the charged OPC by the LSU and applying toner particles adhering to the developer roller to the electrostatic latent image to form a visible image; and d) transferring the visible image formed on the OPC to a sheet of print paper. In an electrophotographic imaging system which allows a user to select the print resolution or print mode, the charge voltage can be appropriately adjusted depending on the print resolution or print mode, so that a high quality image can be obtained with reduced image concentration variation.

[Representative Drawing]

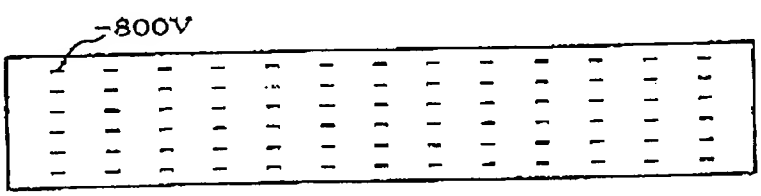
FIG. 4

FIG. 1



Charge roller
130
-1.4kV
190
-800V
180
OPC
-50V
LSU
150
Transfer roller
PTL
170
Developer roller
-1kV or several
to hundreds of kVs
-300V
200
Supply roller
110
120
Power supply
-500V
Controller
140
160

FIG. 2A



-800V

FIG. 2B

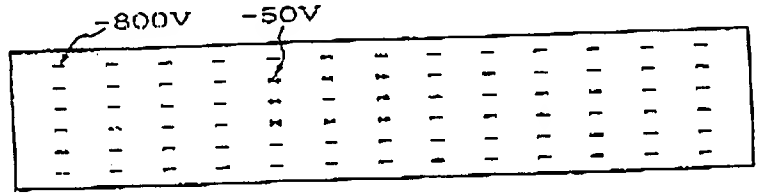


FIG. 2C

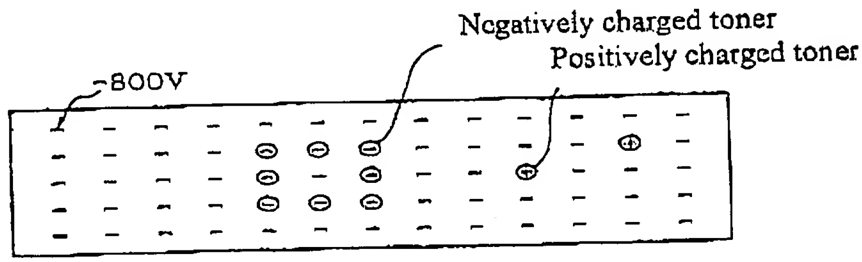


FIG. 2D

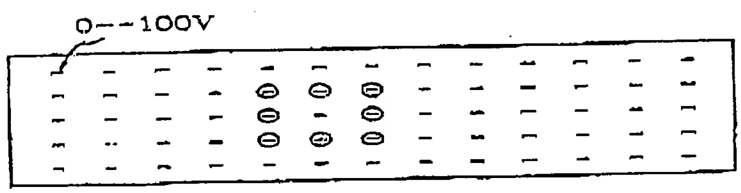


FIG. 3

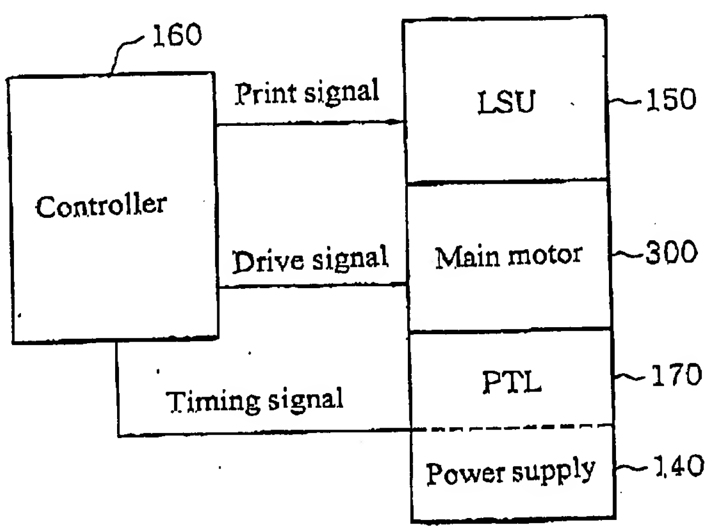


FIG. 4

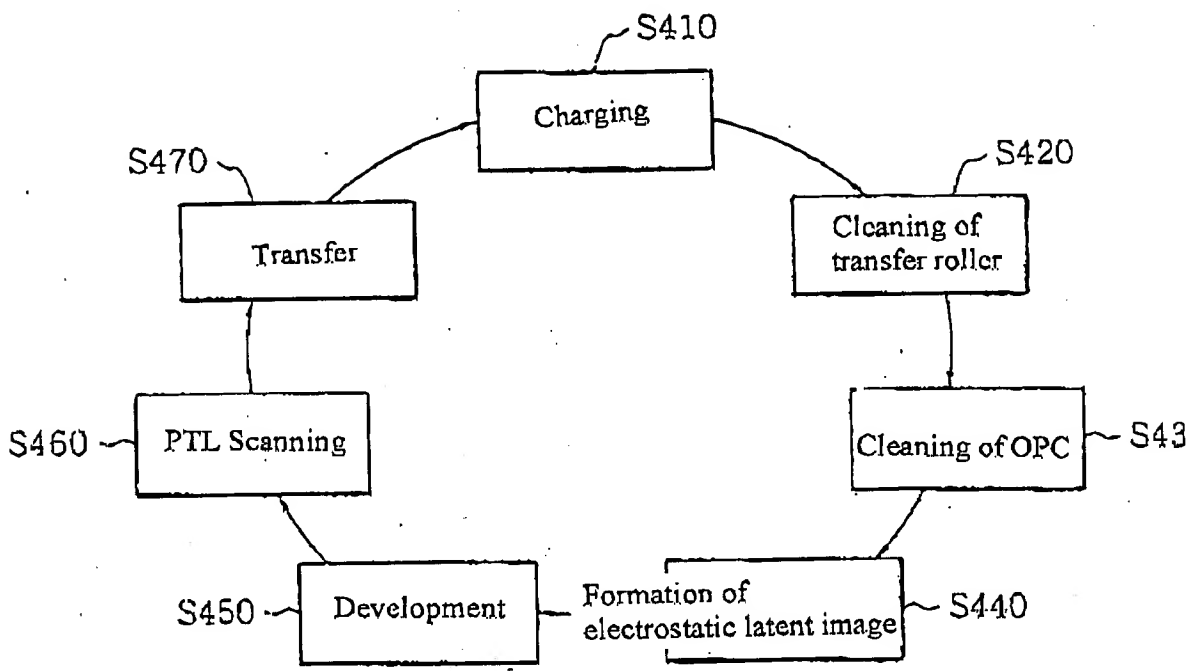
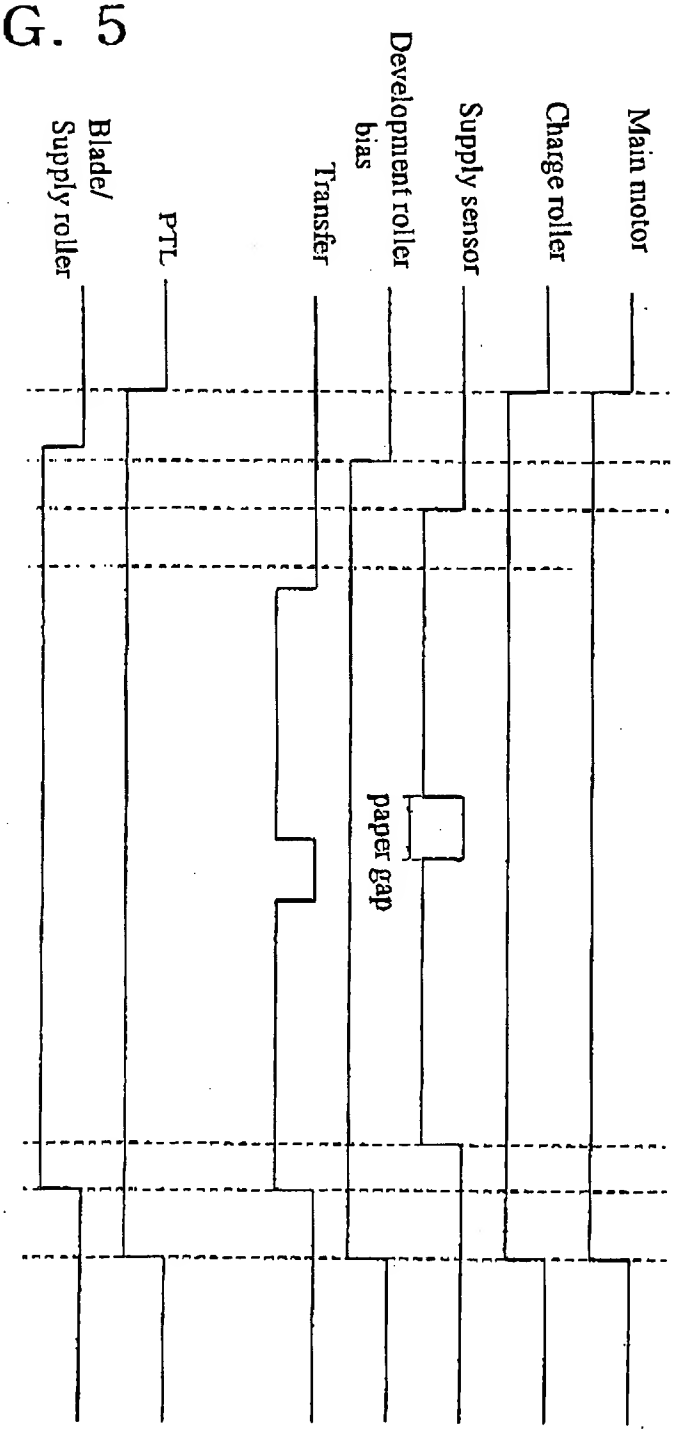
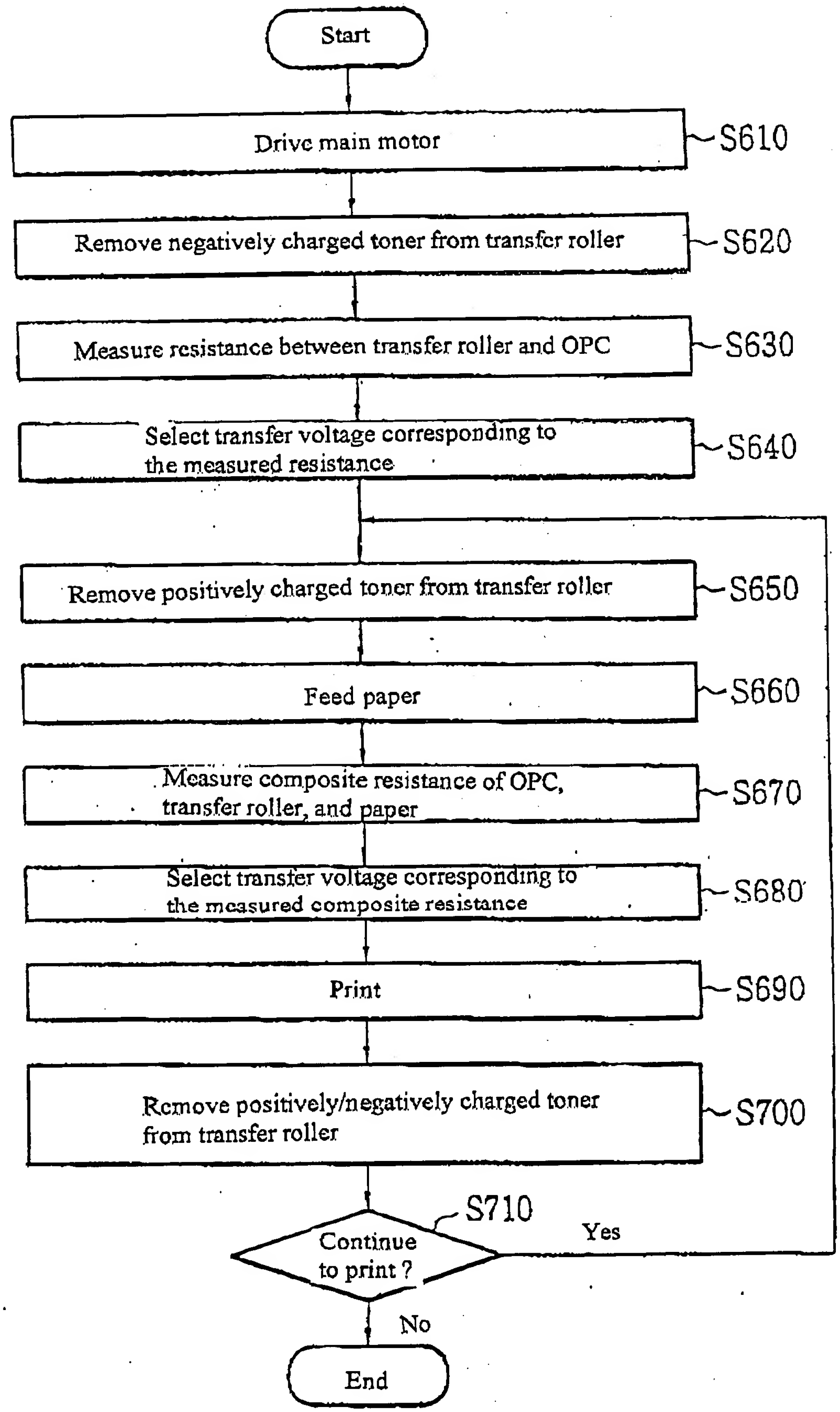

S410
Charging
S420
Cleaning of transfer roller
Cleaning of OPC
S43
Formation of electrostatic latent image
S440
Development
S450
S460
PTL Scanning
S470
Transfer

FIG. 5



Main motor
Charge roller
Supply sensor
Development roller bias
Transfer
PTL
Blade/ Supply roller
paper gap

FIG. 6



Start
Drive main motor
S610
Remove negatively charged toner from transfer roller
S620
Measure resistance between transfer roller and OPC
S630
Select transfer voltage corresponding to the measured resistance
S640
Remove positively charged toner from transfer roller
S650
Feed paper
S660
Measure composite resistance of OPC, transfer roller, and paper
S670
Select transfer voltage corresponding to the measured composite resistance
S680
Print
S690
Remove positively/negatively charged toner from transfer roller
S700
S710
Continue to print ?
Yes
No
End

FIG. 7

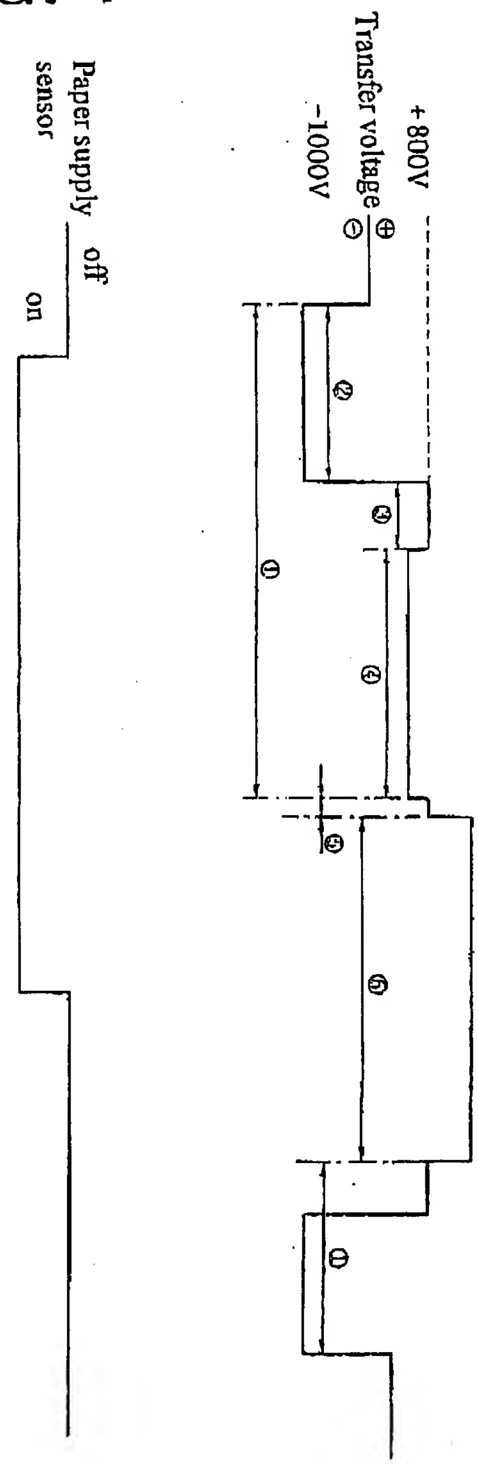


FIG. 8

Resistance between transfer roller and OPC	Positively-charged toner removal voltage
90MΩ or less	500V
110MΩ	600V
125MΩ	700V
150MΩ	900V
200MΩ	1100V
250MΩ	1300V
300MΩ	1500V
400MΩ	1700V
500MΩ	1850V
700MΩ	1900V
800MΩ or more	1900V

FIG. 9A

Composite resistance (R)	Transfer resistance
R<80MΩ	600V
80MΩ≤R<90MΩ	700V
90MΩ≤R<100MΩ	800V
100MΩ≤R<110MΩ	900V
110MΩ≤R<120MΩ	1000V
120MΩ≤R<130MΩ	1100V
130MΩ≤R<140MΩ	1200V
140MΩ≤R<150MΩ	1300V
150MΩ≤R<160MΩ	1400V
160MΩ≤R<170MΩ	1500V
170MΩ≤R<180MΩ	1600V

FIG. 9B

Composite resistance (R)	Transfer resistance
R<200MΩ	1000V
200MΩ≦R<225MΩ	1100V
225MΩ≦R<250MΩ	1200V
250MΩ≦R<275MΩ	1300V
⋮	⋮
400MΩ≦R<500MΩ	1900V

FIG. 9C

Composite resistance (R)	Transfer resistance
R<400MΩ	1600V
400MΩ≦R<450MΩ	1700V
450MΩ≦R<500MΩ	1800V
500MΩ≦R<550MΩ	1900V
⋮	⋮
1000MΩ≦R	2900V

[Document Name]	Amendment to Drawings
[Receiver]	Commissioner
[Filing Date]	13 February 2001
[Submitter]	
[Name]	Samsung Electronics Co.
[Applicant code]	1-1998-104271-3
[Relationship to the case]	Applicant
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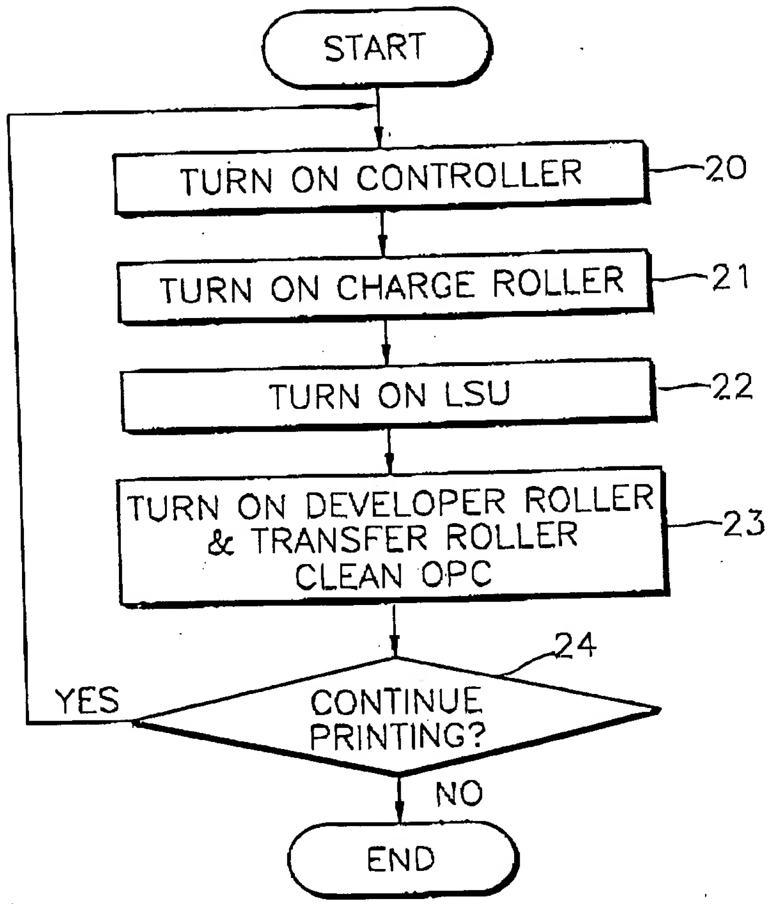
[Name]	Young-pil Lee
[Attorney code]	9-1998-000334-6
[Indication of the case]	
[Application No.]	10-2001-0003747
[Application Date]	26 January 2001
[Date of Request for Examination]	26 January 2001
[Title]	Electrophotographic Printing Method
[Reason for submission]	
[Receipt Number]	1-1-01-0016274-38
[Receipt Data]	26 January 2001
[Document to be amended]	Drawings
[Items to be amended]	
[Item subject to amendment]	Same as in the enclosed document
[Amendment method]	Same as in the enclosed document
[Content of amendment]	Same as in the enclosed document
[Purpose]	We file as above according to Art. 13 of the Patent Law Enforcement rule. Attorney Young-pil Lee
[Fee]	
[Amendment fee]	0 won
[Additional Examination fee]	0 won
[Other fees]	
[Total]	0 won
[Enclosed Document]	Amended Document 1 copy

[Item subject to amendment] FIG. 2
[Amendment method] Addition
[Content of amendment]



[Document Name]	Amendment to Drawings
[Receiver]	Commissioner
[Filing Date]	10 February 2001
[Submitter]	
[Name]	Samsung Elcctronics Co.
[Applicant code]	1-1998-104271-3
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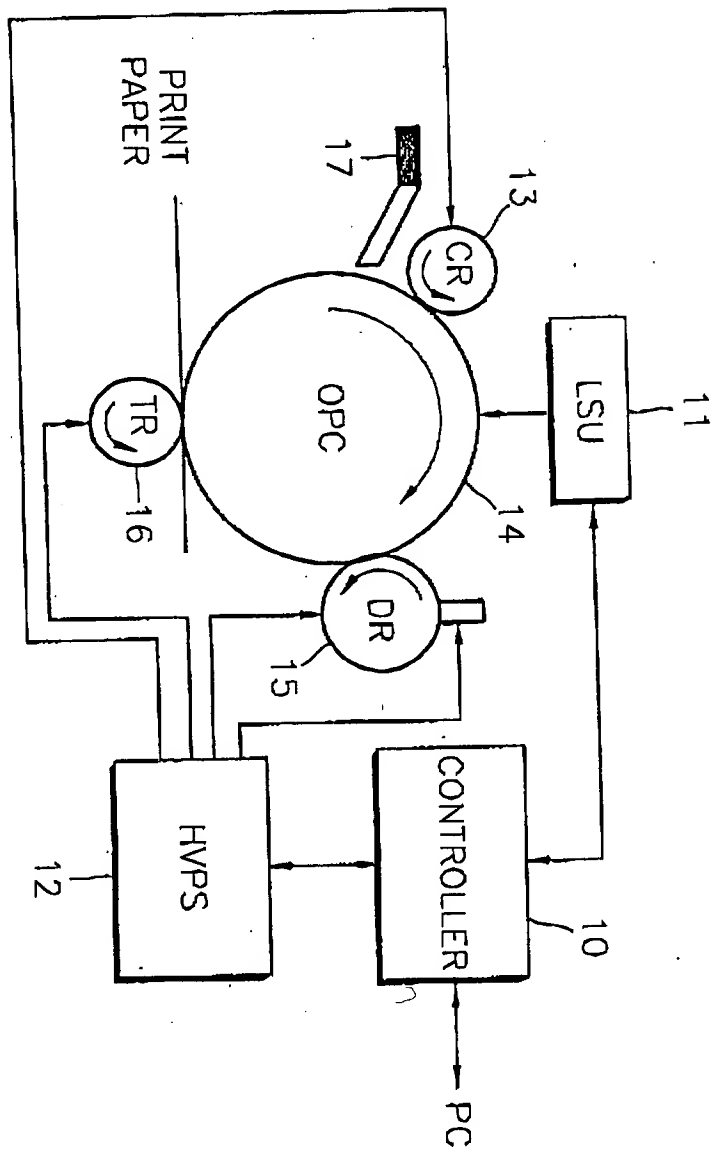
[Attorney code]	9-1998-000334-6
[Indication of the case]	
[Application No.]	10-2001-0003747
[Application Date]	26 January 2001
[Date of Request for Examination]	26 January 2001
[Title]	Electrophotographic Printing Method
[Reason for submission]	
[Receipt Number]	1-1-01-0016274-38
[Receipt Data]	26 January 2001
[Document to be amended]	Drawings
[Items to be amended]	
[Item subject to amendment]	Same as in the enclosed document
[Amendment method]	Same as in the enclosed document
[Content of amendment]	Same as in the enclosed document
[Purpose]	We file as above according to Art. 13 of the Patent Law Enforcement rule. Attorney Young-pil Lee
[Fee]	
[Amendment fee]	0 won
[Additional Examination fee]	0 won
[Other fees]	
[Total]	0 won
[Enclosed Document]	Amended Document 1 copy

[Item subject to amendment] FIG. 1
[Amendment method] Correction
[Content of amendment]



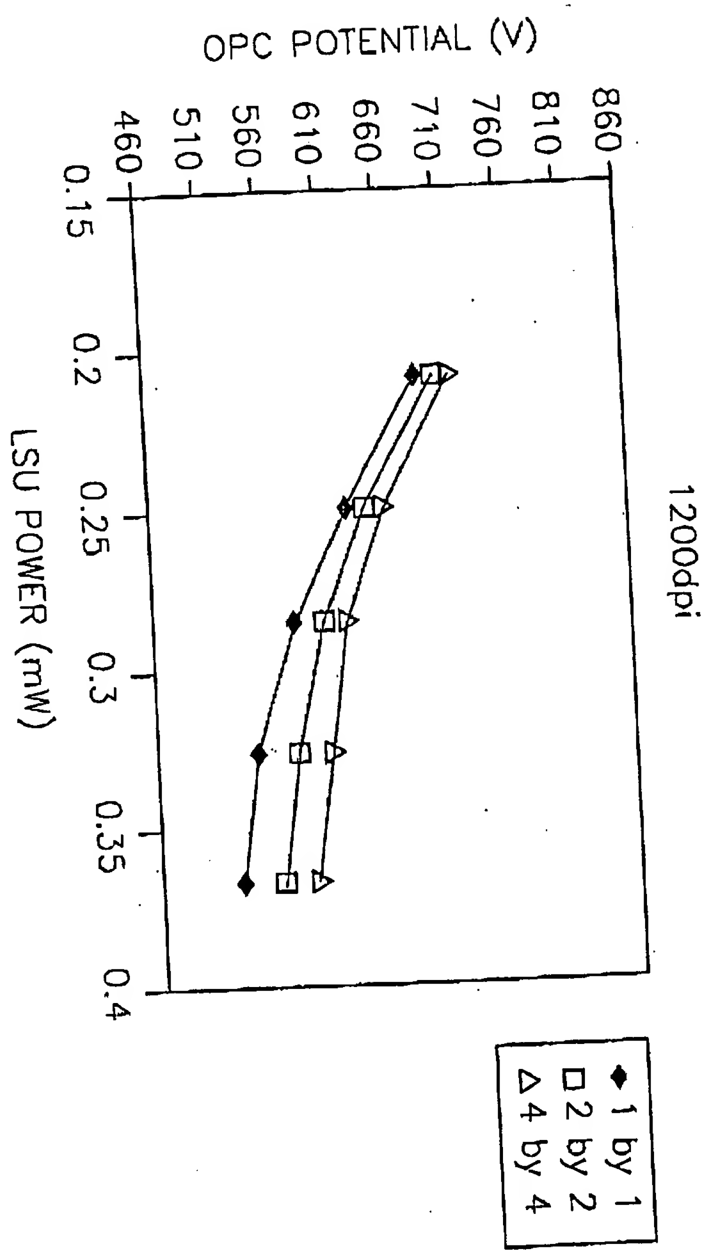
[Item subject to amendment] FIG. 2A
[Amendment method] Deletion

[Item subject to amendment] FIG. 2B
[Amendment method] Deletion

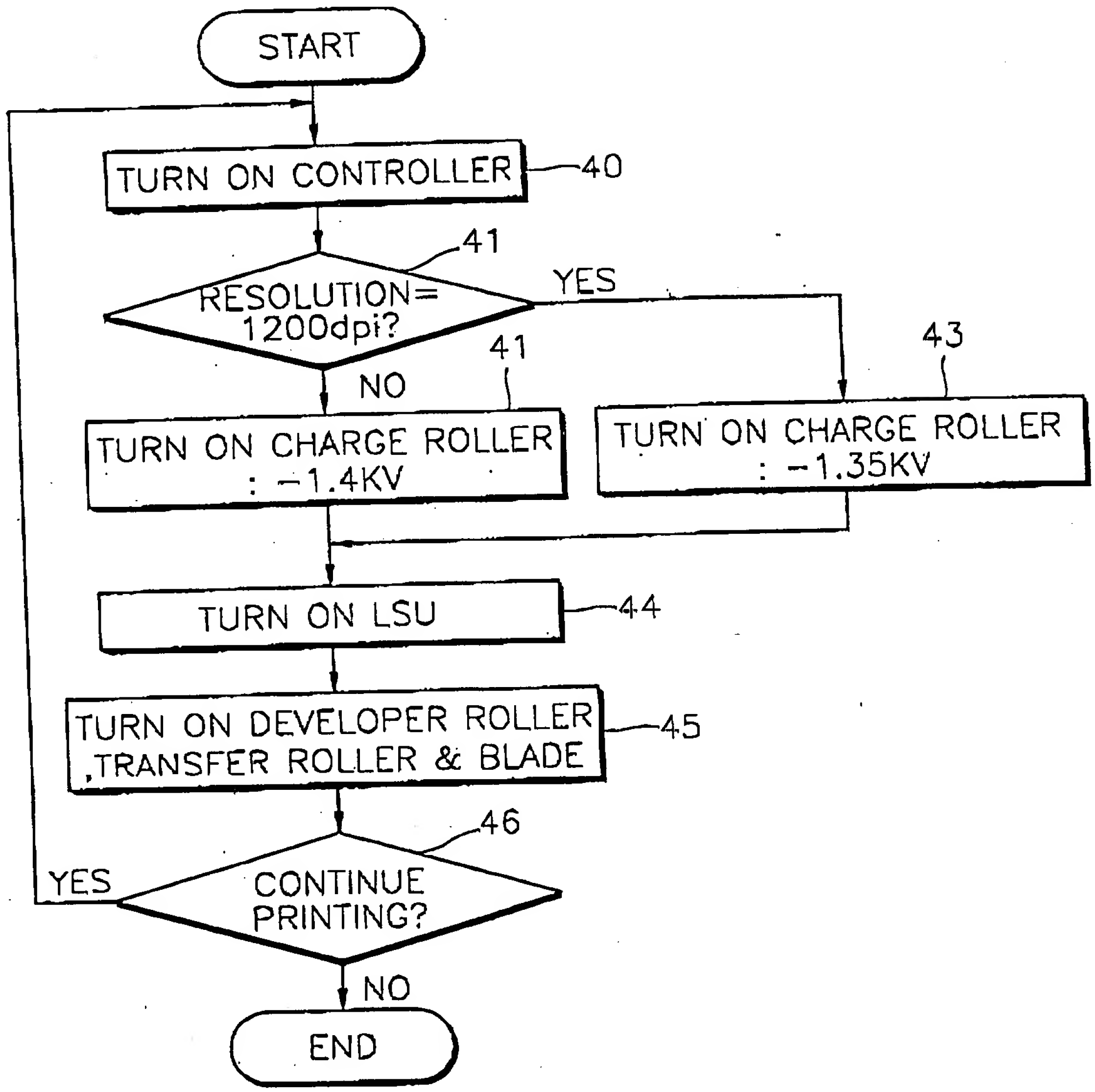
[Item subject to amendment] FIG. 2C
[Amendment method] Deletion

[Item subject to amendment] FIG. 2D
[Amendment method] Deletion

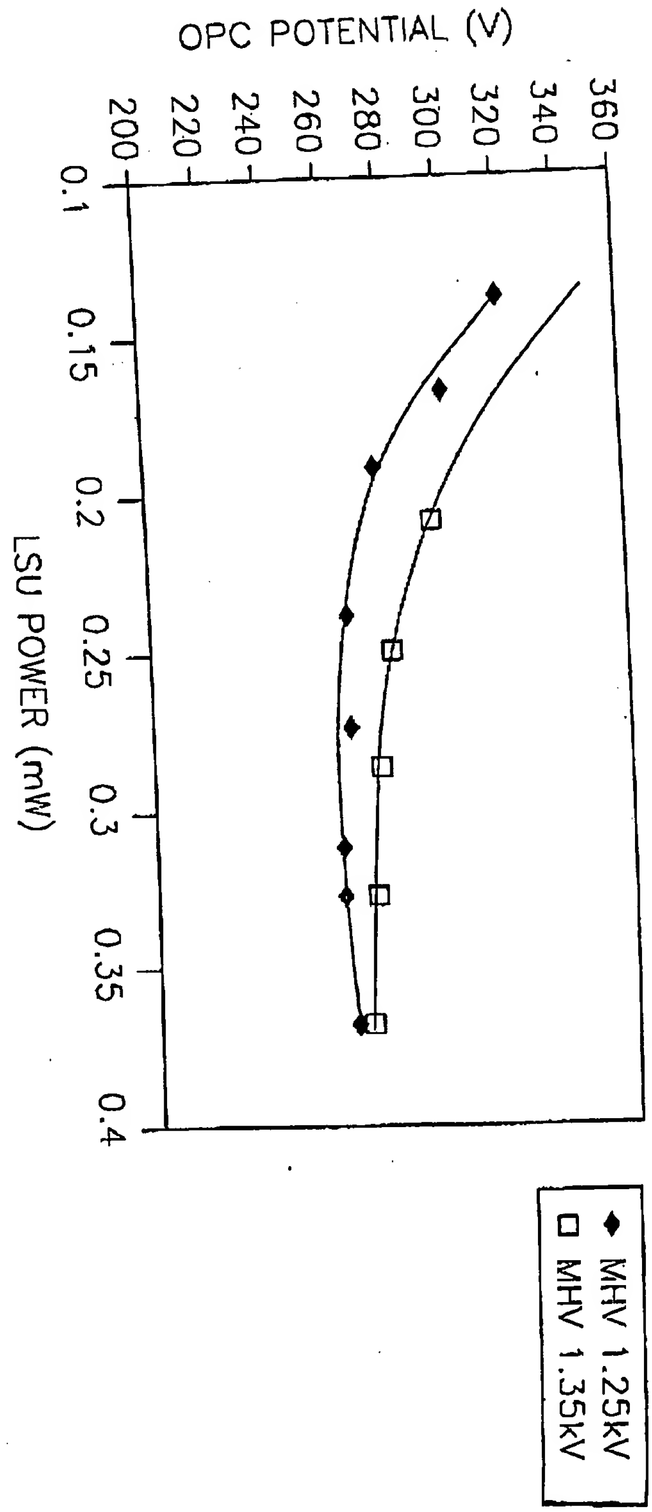
[Item subject to amendment] FIG. 3
[Amendment method] Correction
[Content of amendment]



[Item subject to amendment] FIG. 4
[Amendment method] Correction
[Content of amendment]



[Item subject to amendment] FIG. 5
[Amendment method] Correction
[Content of amendment]



[Item subject to amendment] FIG. 6
[Amendment method] Deletion

[Item subject to amendment] FIG. 7
[Amendment method] Deletion

[Item subject to amendment] FIG. 8
[Amendment method] Deletion

[Item subject to amendment] FIG. 9A
[Amendment method] Deletion

[Item subject to amendment] FIG. 9B
[Amendment method] Deletion

[Item subject to amendment] FIG. 9C
[Amendment method] Deletion